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Associated Health Benefits on Mortality of Reducing Particulate Matter (PM_{2.5}) in Spain

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Introduction: SERCA Project

- ❖ The study was carried out in the framework of the Air Pollution Risk Assessment System (**SERCA**)
- ❖ 3-year project (2009-2011)
- ❖ Spanish network of environmental and public-health professionals
 - Coordinator: Laboratory of Environmental Modelling. Technical University of Madrid (UPM)
 - Institute of Environmental Assessment and Water Research (IDAEA-CSIC)
 - National Center for Epidemiology (ISCIII)

Introduction: background and objective

❖ Background

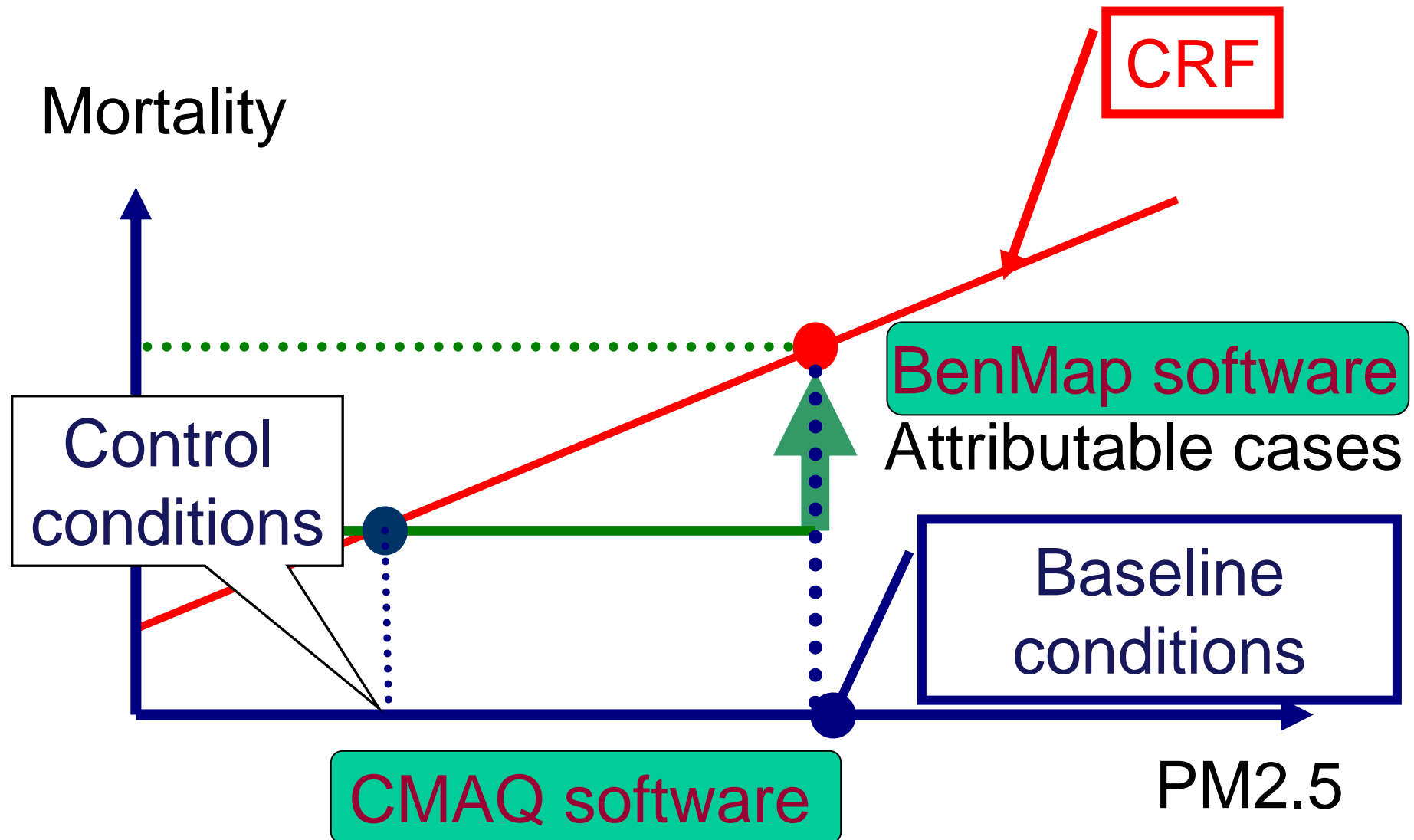
Positive associations between exposure to air pollutants at low concentrations (particularly PM_{2.5}) and adverse health outcomes

❖ Objective

To estimate the number of avoidable deaths associated with reducing PM_{2.5} levels in Spain

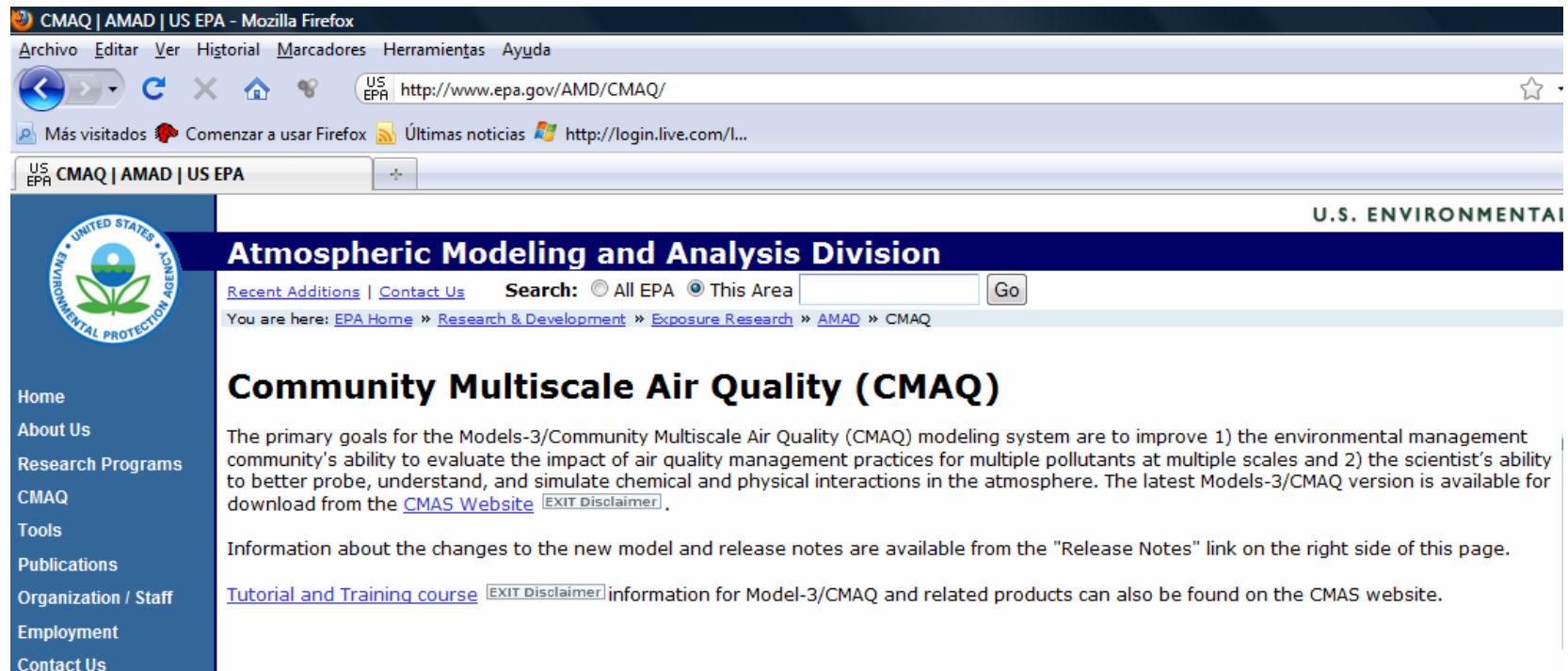
HIA methodology

Adapted from *Künzli, Kaiser, Medina et al, Lancet 2000; 356: 795 - 801*



Methodology: Air Quality Change

- ❖ Air quality model tool: **CMAQ** (Community Multiscale Air Quality)
- ❖ Free software to provide baseline and control conditions (US EPA)

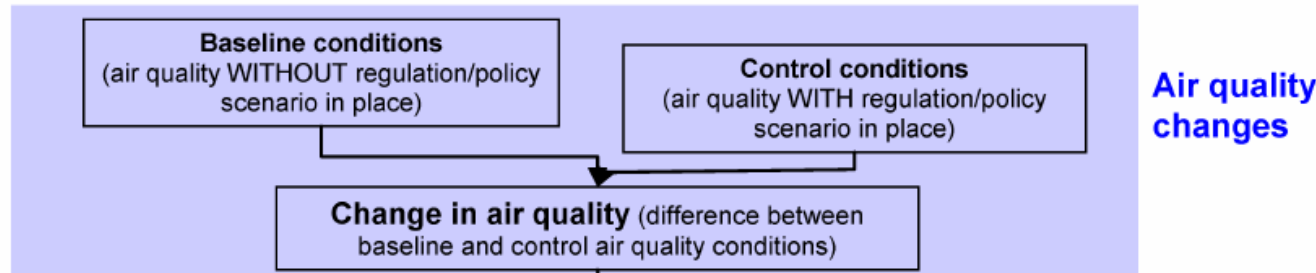


Methodology: Air Quality Change

Air quality modeling data:

❖ **Baseline conditions:** a baseline 2004 scenario based on Spain's National Emissions Inventory

❖ **Control conditions:** a projected 2011 scenario in which a reduction in PM_{2.5} was estimated if specific air quality policies were implemented



Methodology: HIA tool

- ❖ **BenMAP** (Environmental Benefits Mapping and Analysis Program)
- ❖ Free software to estimate health benefits from improvements in air quality (US EPA)

BenMAP | US EPA - Mozilla Firefox

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US EPA <http://www.epa.gov/air/benmap/>

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Environmental Benefits Mapping and Analysis Program (BenMAP)

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BenMAP is a Windows-based computer program that estimates the health benefits from improvements in air quality. BenMAP is powerful enough to perform a comprehensive benefits analysis but simple enough to be used after just a short tutorial. State, local and international users have relied upon BenMAP to estimate the health benefits of improved air quality. BenMAP includes nearly all of the information users would need to start performing a benefits analysis; advanced users can customize the program to meet their analytical needs. Because BenMAP is based on a GIS, the results can be mapped for ease of presentation.

Some of the purposes for which BenMAP is used include the following:

1. Generation of population/community level ambient pollution exposure maps;
2. Comparison of benefits across multiple regulatory programs;
3. Estimation of health impacts associated with exposure to existing air pollution concentrations;
4. Estimation of health benefits of alternative ambient air quality standards;
5. Performance of sensitivity analyses of health or valuation functions, or of other inputs; and
6. Hypothetical, or "what-if," type analyses.

More Information:

[Basic Information](#) - Basics about BenMAP.

[Documents](#) - Presentations and training materials about BenMAP.

[Downloads](#) - US and international version of BenMAP program and configurations.

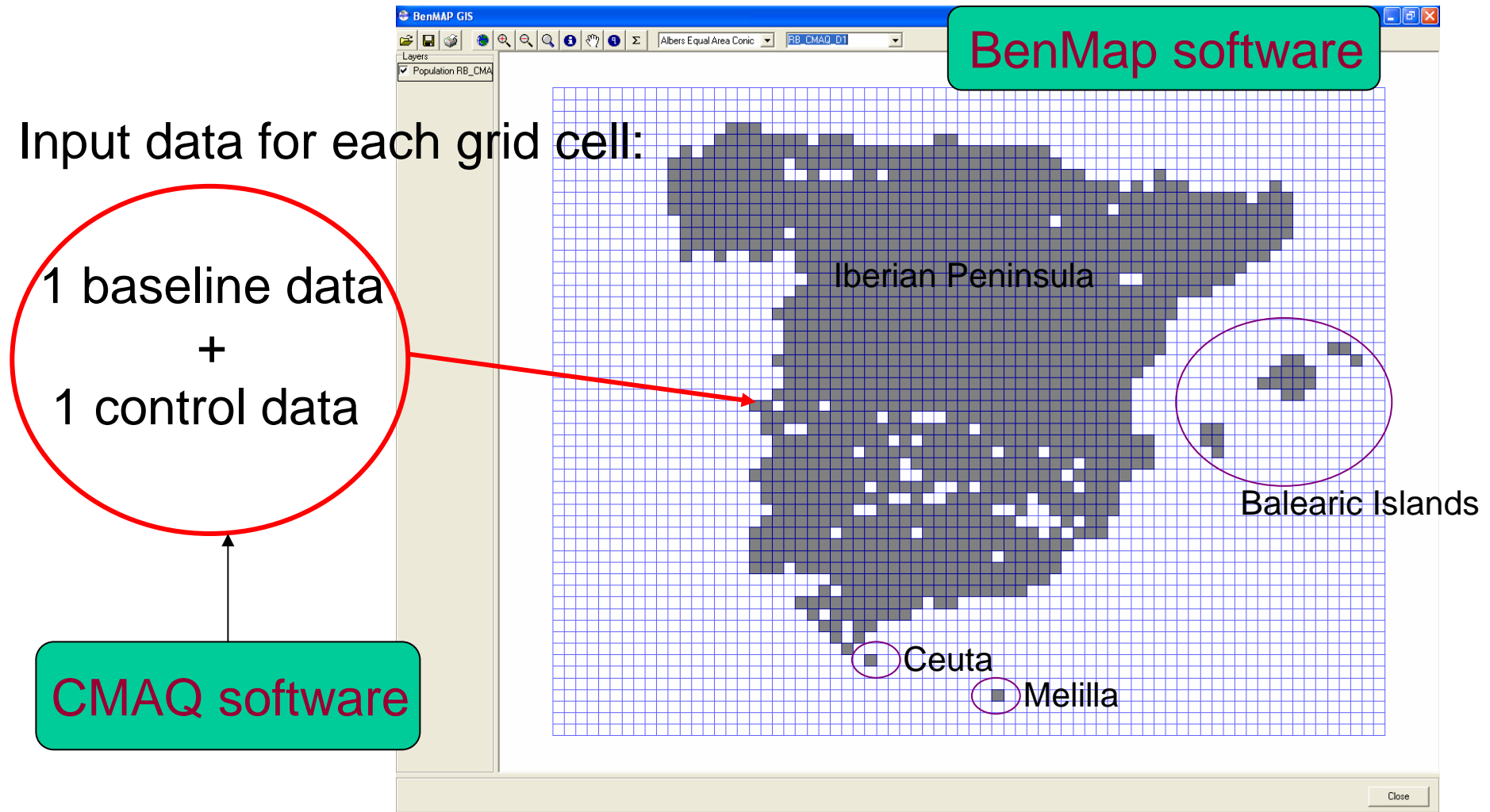
Announcements

- **January 2009:** The U.S. EPA will host a BenMAP training session from January the 26th to the 28th at the CMAS training center in North Carolina. Further information may be found at <http://www.cmascenter.org/imer>
- **2008:** EPA released version 3.0 of BenMAP which includes a new version of the BenMAP user manual and has been integrated directly into the BenMAP program.
- **October 2007:** EPA released the BenMAP program for the first time.

BenMAP
Environmental Benefits Mapping and Analysis Program

Methodology: Air Quality Change

Gridded information with 18 Km² spatial resolution

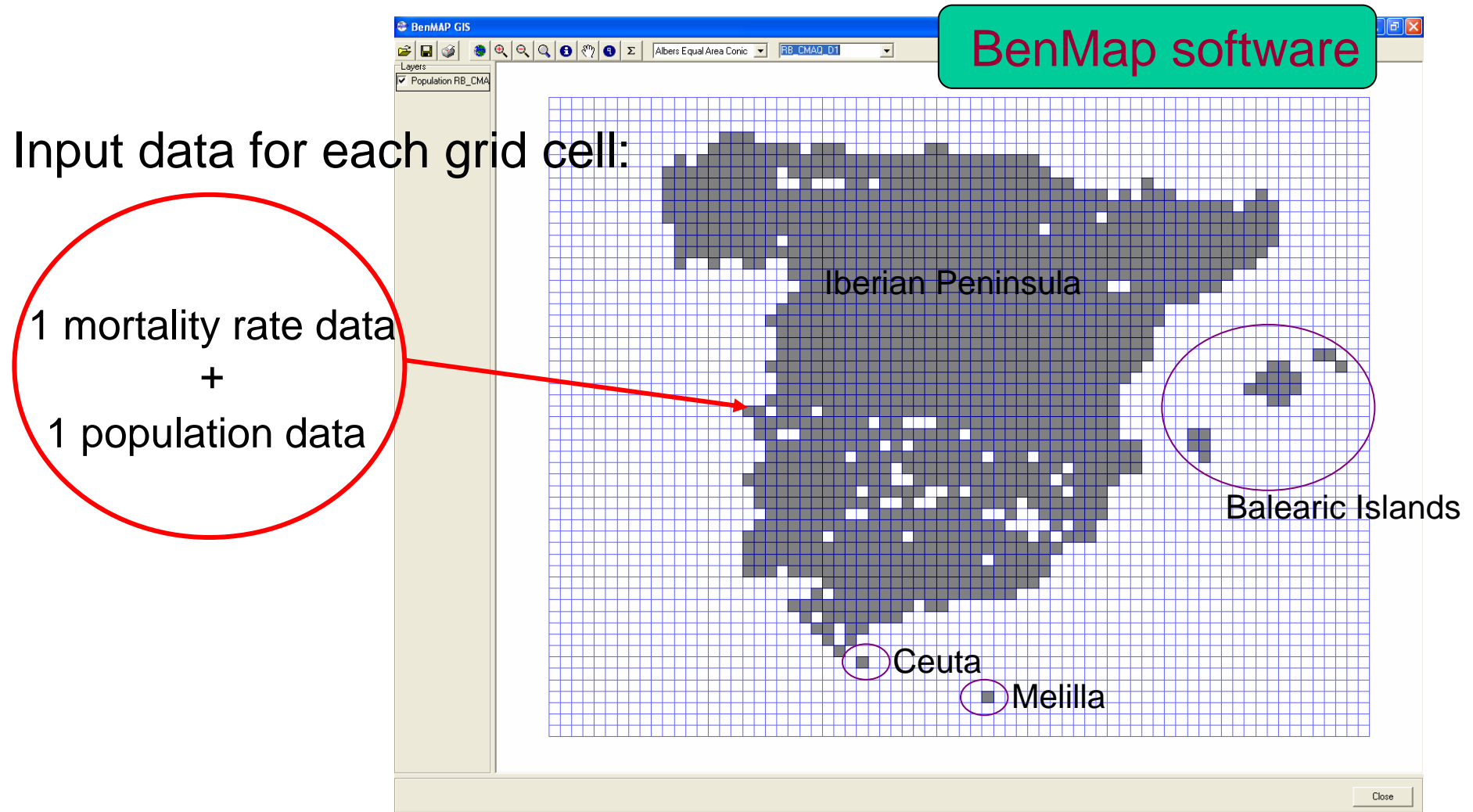


Linking air quality modelling and human impact assessment through the BenMAP

Methodology: Health effects (mortality)

- ❖ Spanish National Statistics Institute (INE) provided population and mortality data for each town (8,109 municipal cores)
- ❖ 2004-2006 Crude all-cause **mortality** rates (ICD-10: A00-Y98) for the over-30 and 25-74 age groups
- ❖ 2004 **population** figures corresponding to these same age groups

Methodology: Mortality rate and population



Methodology: CRF

❖ We used two CRFs linked to PM_{2.5} exposure (Laden et al., 2006; Pope et al., 2002)

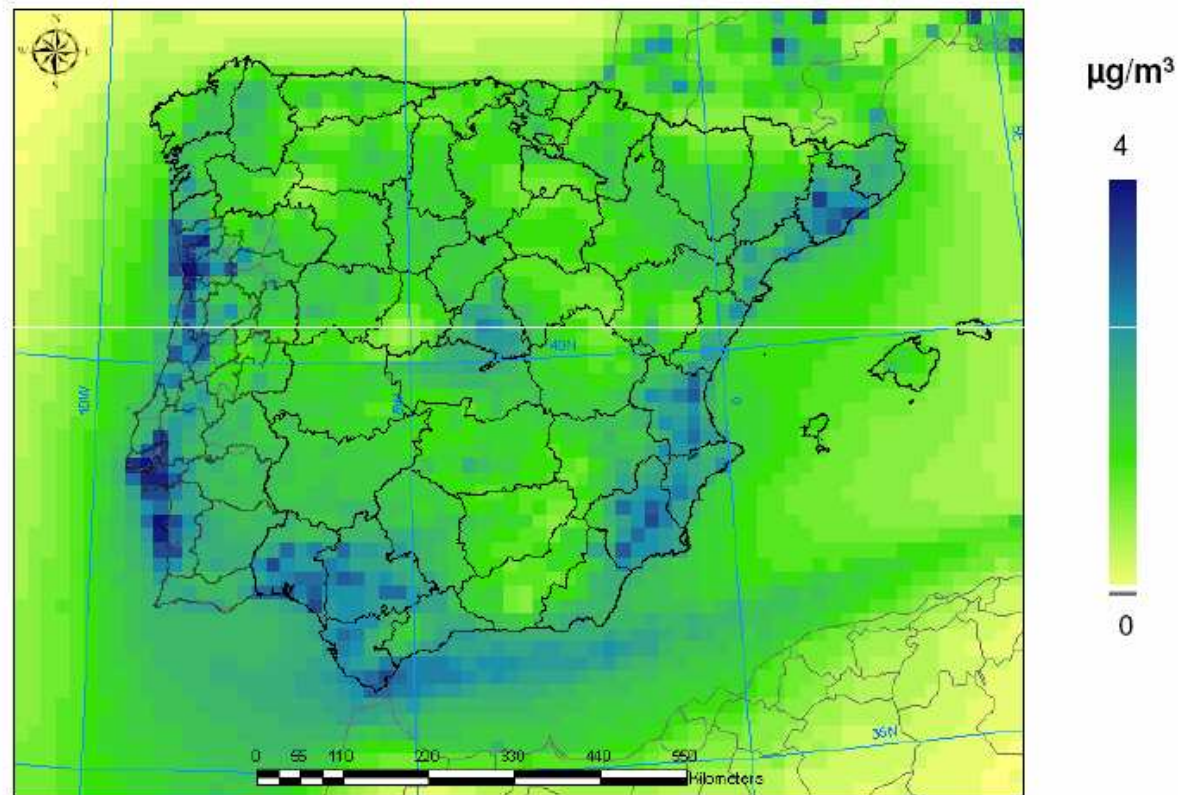
Study features			Regression coefficient (β)		
Author	Location	Study population (age groups)	Mean estimate	Std. Error	β distribution
Pope et al., 2002	51 US cities	500,000 (30-99 years)	$5.8 \cdot 10^{-3}$	$2.1 \cdot 10^{-3}$	Normal
Laden et al., 2006	6 US cities	8,096 (25-74 years)	$14.8 \cdot 10^{-3}$	$4.1 \cdot 10^{-3}$	Normal

Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 2002; 287:1132-41

Laden F, Schwartz J, Speizer FE, Dockery DW. Reduction in fine particulate air pollution and mortality: extended follow-up of the Harvard Six Cities study. Am J Respir Crit Care Med 2006; 173:667-72

Results: Air Quality Change

Modeled PM_{2.5} change between baseline scenario (2004) and control scenario (2011)



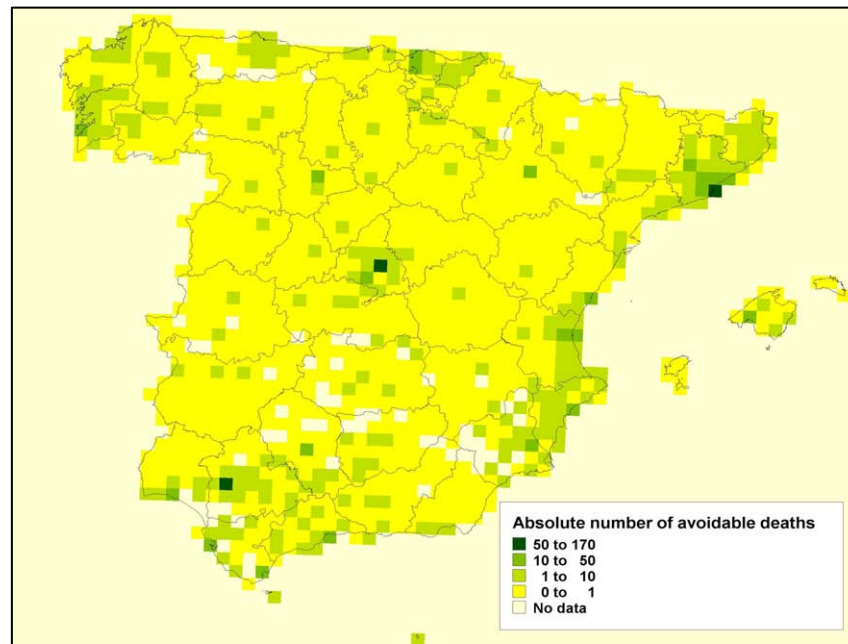
Air quality improvement was defined as an average annual reduction of 0.7 mg/m³ in PM_{2.5} levels

Results: assessing the health impacts

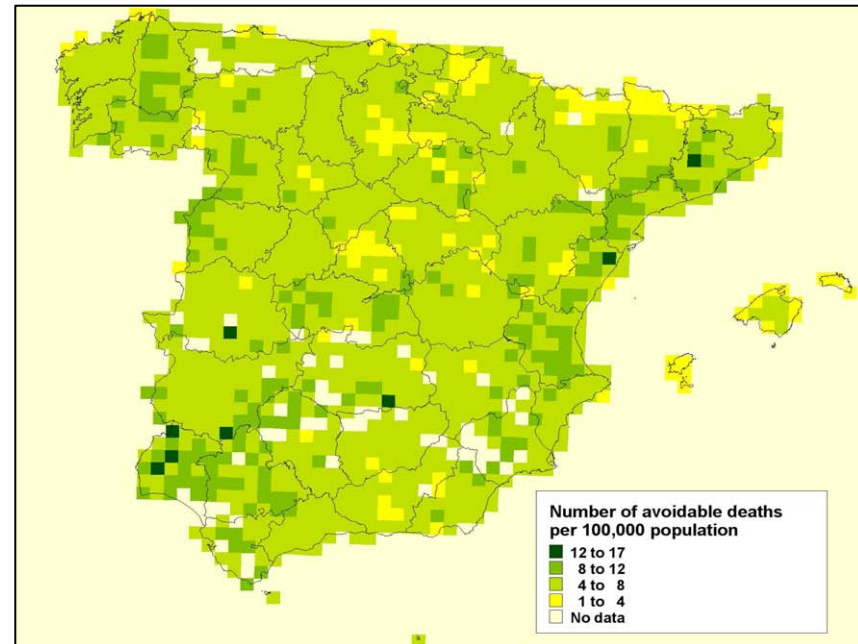
PM2.5: LONG-TERM HEALTH IMPACT ON ALL CAUSES MORTALITY IN SPAIN (SCENARIO 2004-2011)

HIA estimations according to Pope et al., 2002

Absolute number of annual
avoidable deaths



Crude rates of avoidable
deaths/ 100,000 population



Number of annual avoided premature deaths attributable to PM2.5 ($\mu\text{g}/\text{m}^3$) in Spain. Concentration response function corresponding to Pope (2002). ICD-10: A00-Y98. Age group: 30-99. Air quality baseline scenario: 2004 year; air quality control scenario: 2011 year.

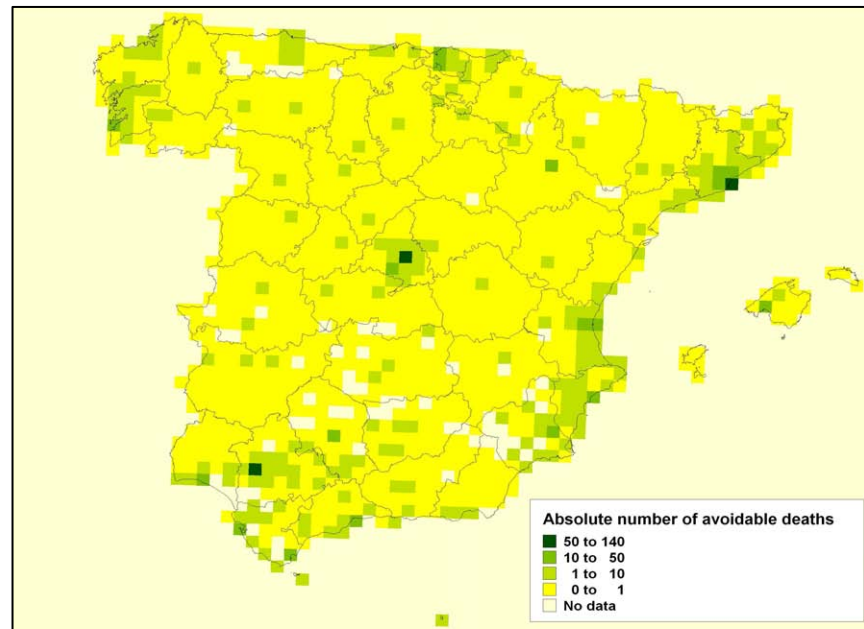
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Results: assessing the health impacts

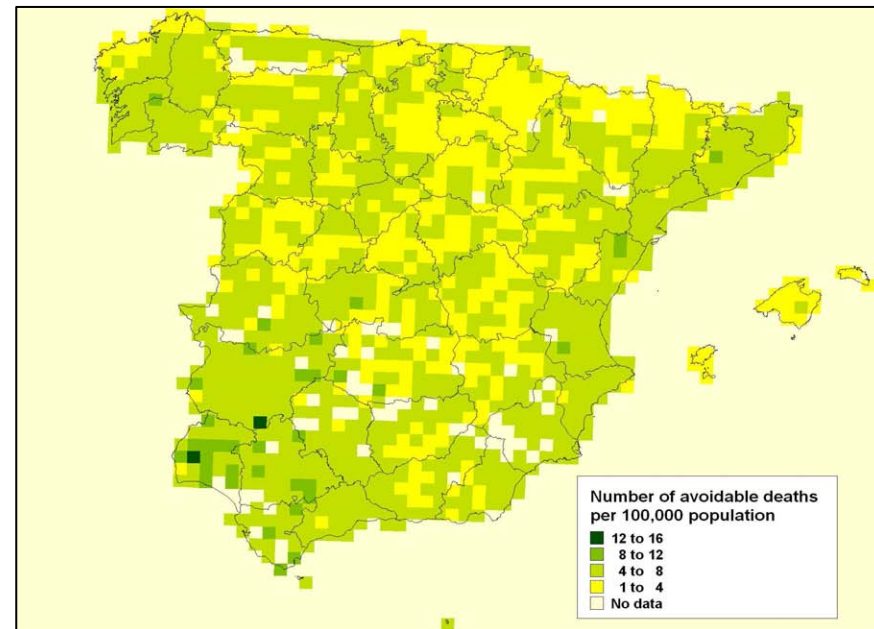
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Results: assessing the health impacts

Summary of long-term HIA findings in terms of potential reductions in the number of attributable deaths and rates per 100,000 population

Exposure indicator	Health indicator	Population at risk (age group)	CRF	Number of avoidable deaths (50 th percentile)	Range of avoidable deaths (5 th –95 th percentiles)	Number of avoidable deaths per 100,000
Long-term PM _{2.5}	All-cause mortality	27,327,894 (30-99 years)	Pope, 2002	1,718	673-2,760	6
		27,581,475 (25-74 years)	Laden, 2006	1,447	780-2,108	5

1,718 all-cause deaths (6 per 100,000 population) in the over-30 age group and 1,447 all-cause deaths (5 per 100,000 population) in the 25-74 age group could be prevented annually

Discussion

- ❖ The validity of HIA estimates depends on:
 - ❖ Quality of population and health data
 - ❖ Quality of exposure data
 - ❖ Risk estimates
- ❖ Our overall results are consistent with previous HIA studies undertaken in Europe and Spain
- ❖ BenMAP could be a suitable tool for future HIA in Spain and in other European countries

Summary

- ❖ Potential benefits in mortality if pollution control policies were successfully implemented by 2011
- ❖ First attempt to perform a national HIA of air pollution in Spain

Associated Health Benefits on Mortality of Reducing Particulate Matter (PM2.5) in Spain (109)

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